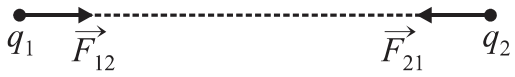
Class: XII
SESSION : 2022-2023
CBSE SAMPLE QUESTION PAPER (THEORY)
SUBJECT: PHYSICS

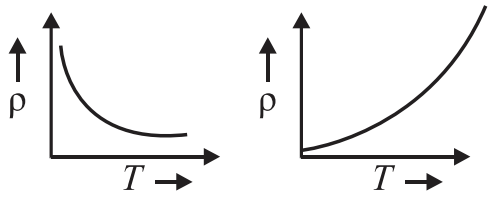
Maximum Marks: 70 Marks **Time Allowed**: 3 hours.

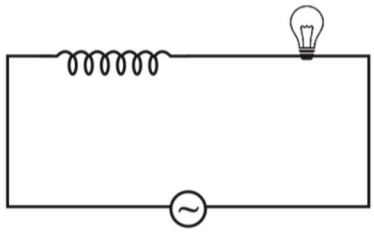
General Instructions:

(1) There are 35 questions in all. All questions are compulsory
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

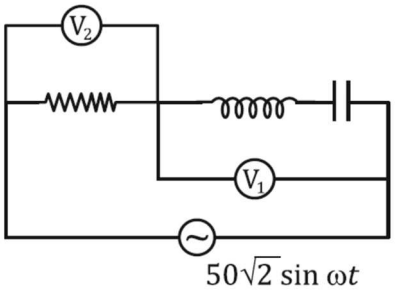
SECTION A

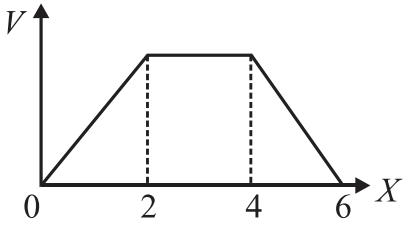
Q. NO.		MARKS
1	**According to Coulomb's law, which is the correct relation for the following figure?**  (i) $q_1 q_2 > 0$ (ii) $q_1 q_2 < 0$ (iii) $q_1 q_2 = 0$ (iv) $1 > q_1/q_2 > 0$	1
2	**The electric potential on the axis of an electric dipole at a distance 'r from it's centre is V. Then the potential at a point at the same distance on its equatorial line will be** (i) 2V (ii) -V (iii) V/2 (iv) Zero	1

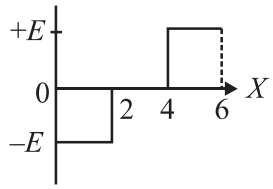
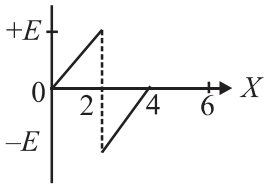
3	**The temperature (T) dependence of resistivity of materials A and material B is represented by fig (i) and fig (ii) respectively. Identify material A and material B.**  fig. (i) fig. (ii) (i) material A is copper and material B is germanium (ii) material A is germanium and material B is copper (iii) material A is nichrome and material B is germanium (iv) material A is copper and material B is nichrome	1
4	**Two concentric and coplanar circular loops P and Q have their radii in the ratio 2:3. Loop Q carries a current 9 A in the anticlockwise direction. For the magnetic field to be zero at the common centre, loop P must carry** (i) 3A in clockwise direction (ii) 9A in clockwise direction (iii) 6 A in anti-clockwise direction (iv) 6 A in the clockwise direction.	1
5	**A long straight wire of circular cross section of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnitudes of magnetic field at a point distant a/2 above the surface of wire to that at a point distant a/2 below its surface is** (i) 4 :1 (ii) 1:1 (iii) 4: 3 (iv) 3 :4	1
6	**If the magnetizing field on a ferromagnetic material is increased, its permeability** (i) decreases (ii) increases (iii) remains unchanged (iv) first decreases and then increases	1

7	**An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. When iron piece is taken out of the coil, the brightness of the bulb will**  **(i)** decrease (ii) increase (iii) remain unaffected (iv) fluctuate	1
8	**Which of the following statement is NOT true about the properties of electromagnetic waves?** (I) These waves do not require any material medium for their propagation (ii) Both electric and magnetic field vectors attain the maxima and minima at the same time (iii) The energy in electromagnetic wave is divided equally between electric and magnetic fields (iv) Both electric and magnetic field vectors are parallel to each other	1
9	A rectangular, a square, a circular and an elliptical loop, all in the (x-y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{\imath}$.The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for (i) any of the four loops (ii) the circular and elliptical loops (iii) the rectangular, circular and elliptical loops (iv) only the elliptical loops	1

10	**In a Young's double slit experiment, the path difference at a certain point on the screen between two interfering waves is $\frac{1}{8}$th of the wavelength. The ratio of intensity at this point to that at the centre of a bright fringe is close to** (i) 0.80 (ii) 0.74 (iii) 0.94 (iv) 0.85	1
11	**The work function for a metal surface is 4.14 eV. The threshold wavelength for this metal surface is:** (i) 4125 Å (ii) 2062.5 Å (iii) 3000 Å (iv) 6000 Å	1
12	**The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. The radius of the n =3 orbit is** (i) 1.01 x 10^{-10}m (ii) 1.59 X 10^{-10}m (iii) 2.12 x 10^{-10}m (iv) 4.77 X 10^{-10}m	1
13	**Which of the following statements about nuclear forces is not true?** **(i)** The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres. **(ii)** The nuclear force is much weaker than the Coulomb force. **(iii)** The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm. **(iv)** The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.	1
14	**If the reading of the voltmeter V_1 is 40 V, then the reading of voltmeter V_2 is**	1

<table>
<tr><td></td><td> 

(i) 30 V (ii) 58 V (iii) 29 V (iv) 15 V</td><td></td></tr>
<tr><td>15</td><td>The electric potential V as a function of distance X is shown in the figure.
 

The graph of the magnitude of electric field intensity E as a function of X is
<table>
<tr><td>(i) 
</td><td>(ii) 
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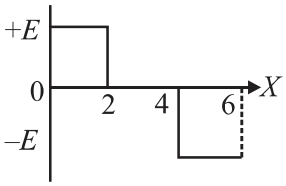
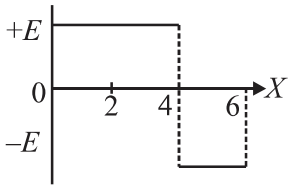
<tr><td>(iii) 
</td><td>(iv) 
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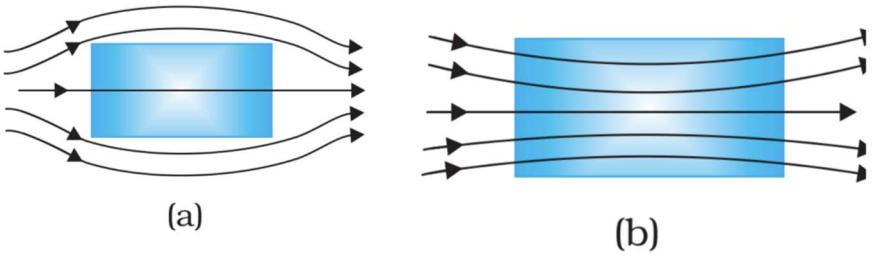
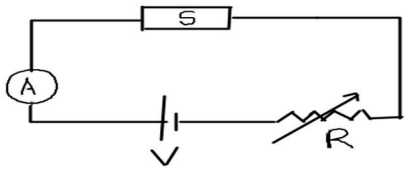
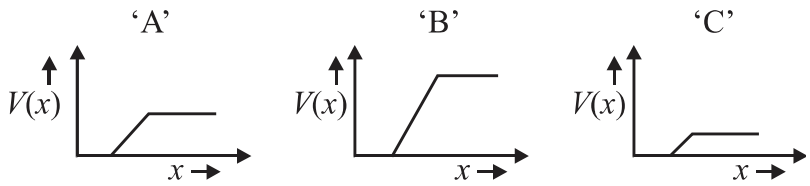
</table></td><td>1</td></tr>
<tr><td>16</td><td>Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true and R is NOT the correct explanation of A</td><td>1</td></tr>
</table>

	c) A is true but R is false **d) A is false and R is also false** **ASSERTION(A):** The electrical conductivity of a semiconductor increases on doping. **REASON:** Doping always increases the number of electrons in the semiconductor.	
17	**Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** **a) Both A and R are true and R is the correct explanation of A** **b) Both A and R are true and R is NOT the correct explanation of A** **c) A is true but R is false** **d) A is false and R is also false** **ASSERTION:** In an interference pattern observed in Young's double slit experiment, if the separation (d) between coherent sources as well as the distance (D) of the screen from the coherent sources both are reduced to 1/3rd, then new fringe width remains the same**.** **REASON:** Fringe width is proportional to (d/D)**.**	1
18	**Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** **a) Both A and R are true and R is the correct explanation of A** **b Both A and R are true and R is NOT the correct explanation of A** **c) A is true but R is false** **d) A is false and R is also false** **Assertion(A)** : The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies. **Reason(R)** :	1

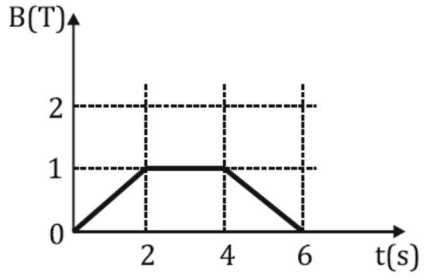
	The energy of electrons emitted from inside the metal surface, is lost in collision with the other atoms in the metal.	

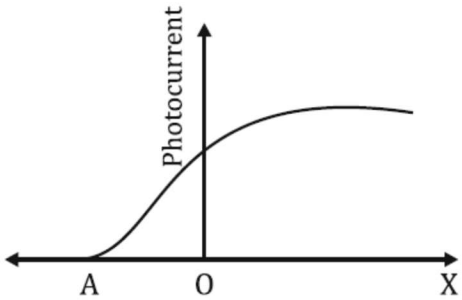
SECTION B

19	Electromagnetic waves with wavelength (i) λ_1 is suitable for radar systems used in aircraft navigation. (ii) λ_2 is used to kill germs in water purifiers. (iii) λ_3 is used to improve visibility in runways during fog and mist conditions. Identify and name the part of the electromagnetic spectrum to which these radiations belong.Also arrange these wavelengths in ascending order of their magnitude.	2
20	A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.  (a) (b) (i)Identify the specimen A and B. **(**ii) How is the magnetic susceptibility of specimen A different from that of specim**e**n B**?**	2
21	What is the nuclear radius of ^{125}Fe ,if that of ^{27} Al is 3.6 fermi?. **OR** The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 **A^0**. Calculate the short wavelength limit for the Balmer series of the hydrogen spectrum.	2
22	A biconvex lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Justify your answer.	2

23	The figure shows a piece of pure semiconductor S in series with a variable resistor R and a source of constant voltage V. Should the value of R be increased or decreased to keep the reading of the ammeter constant, when semiconductor S is heated? Justify your answer  **OR** The graph of potential barrier versus width of depletion region for an unbiased diode is shown in graph A. In comparison to A ,graphs B and C are obtained after biasing the diode in different ways .Identify the type of biasing in B and C and justify your answer.  	2
24	A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equal to 6000 Å and the angular width of the central maximum in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ', the angular width decreases by 30%. Calculate the value of the wavelength λ'.	2
25	Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17.7×10^{-22} C/m^2. What is electric field intensity E: (a) in the outer region of the first plate, and (b) between the plates?	

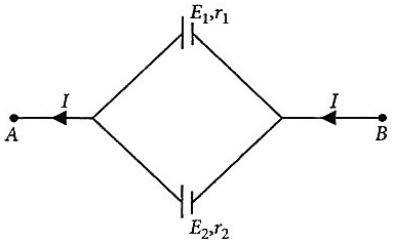
SECTION C

26	Two long straight parallel conductors carrying currents I_1 and I_2 are separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field produced by one exerts an attractive force on the other. Obtain the expression for this force and hence define 1 ampere.	3
27.	The magnetic field through a circular loop of wire, 12cm in radius and 8.5Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the current induced in the loop and plot a graph showing induced current as a function of time.  	3
28	An a.c. source generating a voltage $\varepsilon = \varepsilon_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of ε and I versus ωt to show that the current is ahead of the voltage by π/2. **OR** An ac voltage $V = V_0 \sin \omega t$ is applied across a pure inductor of inductance *L*. Find an expression for the current *i*, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\frac{\pi}{2}$. Also draw graphs of *V* and *i* versus ωt for the circuit.	3
29	Radiation of frequency 10^{15} Hz is incident on three photosensitive surfaces A, B and C. Following observations are recorded: **Surface A**: no photoemission occurs **Surface B**: photoemission occurs but the photoelectrons have zero kinetic energy.	3

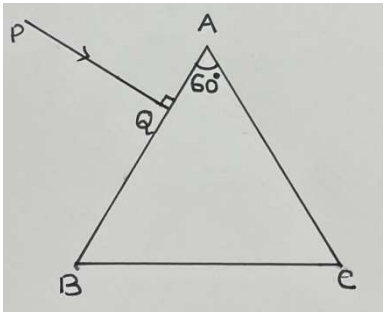
	Surface C: photo emission occurs and photoelectrons have some kinetic energy. Using Einstein's photo-electric equation, explain the three observations. **OR** **The graph shows the variation of photocurrent for a photosensitive metal**  (a)What does X and A on the horizontal axis represent? (b)Draw this graph for three different values of frequencies of incident radiation υ_1, υ_2 and υ_3 ($\upsilon_3 > \upsilon_2 > \upsilon_1$) for the same intensity. (c) Draw this graph for three different values of intensities of incident radiation I_1, I_2 and I_3 ($I_3 > I_2 > I_1$) having the same frequency.	
30	The ground state energy of hydrogen atom is -13.6 eV. The photon emitted during the transition of electron from n=3 to n=1 state, is incident on a photosensitive material of unknown work function .The photoelectrons are emitted from the material with the maximum kinetic energy of 9eV.Calculate the threshold wavelength of the material used.	3

SECTION D

31	(a)Draw equipotential surfaces for (i)an electric dipole and (ii) two identical positive charges placed near each other. (b) In a parallel plate capacitor with air between the plates, each plate has an area of $6 \times 10^{-3} m^2$ and the separation between the plates is 3 mm. (i) Calculate the capacitance of the capacitor. (ii) If the capacitor is connected to 100V supply, what would be the the charge on each plate? (iii) How would charge on the plate be affected if a 3 mm thick mica sheet of k=6 is inserted between the plates while the voltage supply remains connected ?.	5

	OR (a)Three charges –q, Q and –q are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio Q:q? (b)(i) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it. (ii) Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R.	
32	(a) Explain the term drift velocity of electrons in a conductor .Hence obtain the expression for the current through a conductor in terms of drift velocity. (b) Two cells of emfs E_1 and E_2 and internal resistances $r_1$and r_2 respectively are connected in parallel as shown in the figure. Deduce the expression for the (i) equivalent emf of the combination (ii) equivalent internal resistance of the combination (iii) potential difference between the points *A* and *B*.  **OR** (a) State the two Kirchhoff's rules used in the analysis of electric circuits and explain them. (b) Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws.	5
33	a) Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through a single slit. What is the width of the central maximum in comparison to that of a secondary maximum? b) A ray PQ is incident normally on the face AB of a	5

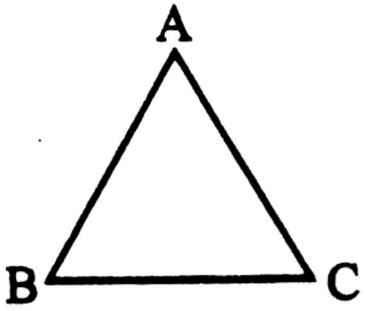
triangular prism of refracting angle 60^0 as shown in figure. The prism is made of a transparent material of refractive index $\frac{2}{\sqrt{3}}$. Trace the path of the ray as it passes through the prism. Calculate the angle of emergence and the angle of deviation.



OR

a) Write two points of difference between an interference pattern
and a diffraction pattern.

b) (i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.



(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

SECTION E

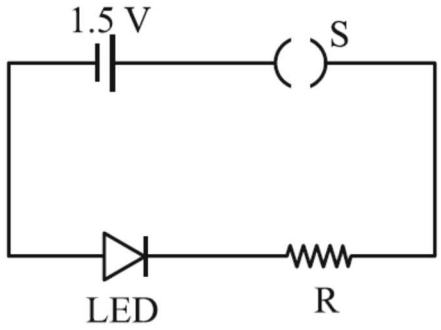
34	**Case Study :** ***Read the following paragraph and answer the questions.*** A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilising the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices. (i) Why the image formed at infinity is often considered most suitable for viewing. Explain (ii) In modern microscopes multicomponent lenses are used for both the objective and the eyepiece. Why? (iii) Write two points of difference between a compound microscope and an astronomical telescope **OR** (iii) Write two distinct advantages of a reflecting type telescope over a refracting type telescope.
35	**Case study: Light emitting diode.** **Read the following paragraph and answer the questions** **LED** is a heavily doped P-N junction which under forward bias emits spontaneous radiation. When it is forward biased, due to recombination of holes and electrons at the junction, energy is released in the form of photons. In the case of Si and Ge diode, the energy released in recombination lies in the infrared region. LEDs that can emit red, yellow, orange, green and blue light are commercially available. The semiconductor used for fabrication of visible LEDs must at least have a band gap of 1.8 eV. The compound semiconductor Gallium Arsenide – Phosphide is used for making LEDs of different colours.

LEDs of different kinds

(i). Why are LEDs made of compound semiconductor and not of elemental semiconductors?

(ii) What should be the order of bandgap of an LED, if it is required to emit light in the visible range?

(iii) A student connects the blue coloured LED as shown in the figure. The LED did not glow when switch S is closed. Explain why ?



OR

(iii) Draw V-I characteristic of a p-n junction diode in

(i) forward bias and (ii) reverse bias

SAMPLE PAPER (2022-23)

CHEMISTRY THEORY

(043)

MM:70 **Time: 3 hours**

General Instructions:

Read the following instructions carefully.

a) There are **35** questions in this question paper with internal choice.

b) SECTION A consists of 18 multiple-choice questions carrying 1 mark each.

c) SECTION B consists of 7 very short answer questions carrying 2 marks each.

d) SECTION C consists of 5 short answer questions carrying 3 marks each.

e) SECTION D consists of 2 case- based questions carrying 4 marks each.

f) SECTION E consists of 3 long answer questions carrying 5 marks each.

g) **All questions are compulsory.**

h) **Use of log tables and calculators is not allowed**

SECTION A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. The major product of acid catalysed dehydration of 1-methylcyclohexanol is:

a. 1-methylcyclohexane
b. 1-methylcyclohexene
c. 1-cyclohexylmethanol
d. 1-methylenecyclohexane

2. Which one of the following compounds is more reactive towards S_N1 reaction?

a. $CH_2=CHCH_2Br$
b. $C_6H_5CH_2Br$
c. $C_6H_5CH\ (C_6H_5)Br$
d. $C_6H_5CH(CH_3)\ Br$

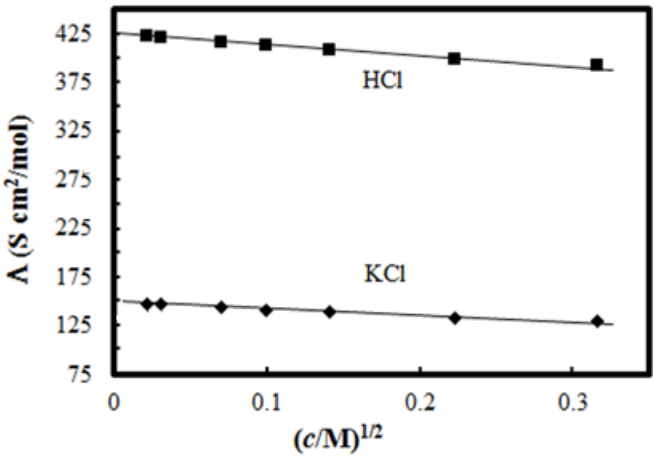
3. $KMnO_4$ is coloured due to:

a. d-d transitions
b. charge transfer from ligand to metal
c. unpaired electrons in d orbital of Mn
d. charge transfer from metal to ligand

4. Which radioactive isotope would have the longer half- life ^{15}O or ^{19}O? (Given rate constants for ^{15}O and ^{19}O are $5.63 \times 10^{-3}\ s^{-1}$ and $k = 2.38 \times 10^{-2} s^{-1}$ respectively.)

   a. ^{15}O
   b. ^{19}O
   c. Both will have the same half-life
   d. None of the above, information given is insufficient

5. The molar conductivity of CH_3COOH at infinite dilution is 390 Scm^2/mol. Using the graph and given information, the molar conductivity of CH_3COOK will be:



   a. 100 Scm^2/mol
   b. 115 Scm^2/mol
   c. 150 Scm^2/mol
   d. 125 Scm^2/mol

***FOR VISUALLY CHALLENGED LEARNERS**

*5. What is the molar conductance at infinite dilution for sodium chloride if the molar conductance at infinite dilution of Na^+ and Cl^- ions are $51.12 \times 10^{-4}\ Scm^2/mol$ and $73.54 \times 10^{-4}\ Scm^2/mol$ respectively?

   a. 124.66 Scm^2/mol
   b. 22.42 Scm^2/mol
   c. 198.20Scm^2/mol
   d. 175.78 Scm^2/mol

6. For the reaction, A +2B → AB_2, the order w.r.t. reactant A is 2 and w.r.t. reactant B. What will be change in rate of reaction if the concentration of A is doubled and B is halved?

a. increases four times
b. decreases four times
c. increases two times
d. no change

7. Arrange the following in the increasing order of their boiling points:

A : Butanamine, B: N,N-Dimethylethanamine, C: N- Etthylethanaminamine

a. C<B<A
b. A<B<C
c. A<C<B
d. B<C<A

8. The CFSE of $[CoCl_6]^{3-}$ is 18000 cm^{-1} the CFSE for $[CoCl_4]^-$ will be:

a. 18000 cm^{-1}
b. 8000cm^{-1}
c. 2000 cm^{-1}
d. 16000 cm^{-1}

9. What would be the major product of the following reaction?

C_6H_5 -CH_2-OC_6H5 + HBr → A + B

a. A= $C_6H_5CH_2OH$, B= C_6H_6
b. A=$C_6H_5CH_2OH$,B= C6H5Br
c. A=$C_6H_5CH_3$,B= C_6H_5Br
d. A=$C_6H_5CH_2Br$, B= C_6H_5OH

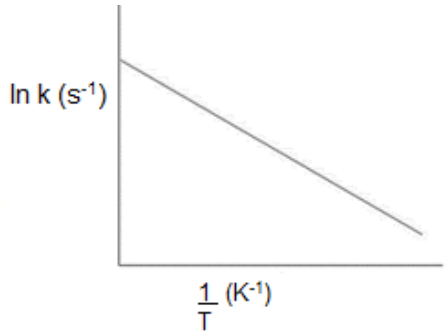
10. Which of the following statements is not correct for amines?

a. Most alkyl amines are more basic than ammonia solution.
b. pK_b value of ethylamine is lower than benzylamine.
c. CH_3NH_2 on reaction with nitrous acid releases NO_2 gas.
d. Hinsberg's reagent reacts with secondary amines to form sulphonamides.

11. Which of the following tests/ reactions is given by aldehydes as well as ketones?

a. Fehling's test
b. Tollen's test
c. 2,4 DNP test
d. Cannizzaro reaction

12. Arrhenius equation can be represented graphically as follows:



The (i) intercept and (ii) slope of the graph are:

a. (i) ln A (ii) Ea/R
b. (i) A (ii) Ea
c. (i)ln A (ii) - Ea/R
d. (i) A (ii) -Ea

***FOR VISUALLY CHALLENGED LEARNERS**

*12. The unit of rate constant for the reaction

$2A + 2B \rightarrow A_2B_2$

which has rate = $k [A]^2[B]$ is**:**

a. mol $L^{-1}s^{-1}$
b. s^{-1}
c. mol L^{-1}
d. $mol^{-2}\ L^2\ s^{-1}$

13. The number of ions formed on dissolving one molecule of $FeSO_4.(NH_4)_2SO_4.6H_2O$ in water is:

a. 3
b. 4
c. 5
d. 6

14. The oxidation of toluene to benzaldehyde by chromyl chloride is called

a. Etard reaction
b. Riemer-Tiemann reaction
c. Stephen's reaction
d. Cannizzaro's reaction

15. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): An ether is more volatile than an alcohol of comparable molecular mass.

Reason (R): Ethers are polar in nature.

Select the most appropriate answer from the options given below:

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

16. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): Proteins are found to have two different types of secondary structures viz alpha-helix and beta-pleated sheet structure.

Reason (R): The secondary structure of proteins is stabilized by hydrogen bonding.

Select the most appropriate answer from the options given below:

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

17. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion : Magnetic moment values of actinides are lesser than the theoretically predicted values.

Reason : Actinide elements are strongly paramagnetic.

Select the most appropriate answer from the options given below:

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

18. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): Tertiary amines are more basic than corresponding secondary and primary amines in gaseous state.

Reason (R): Tertiary amines have three alkyl groups which cause +I effect.

Select the most appropriate answer from the options given below:

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

SECTION B

This section contains 7 questions with internal choice in two questions. The following questions are very short answer type and carry 2 marks each.

19. A first-order reaction takes 69.3 min for 50% completion. What is the time needed for 80% of the reaction to get completed?
(Given: log 5 =0.6990, log 8 = 0.9030, log 2 = 0.3010)

20. Account for the following:
    a. There are 5 OH groups in glucose
    b. Glucose is a reducing sugar

OR

What happens when D – glucose is treated with the following reagents
    a. Bromine water
    b. HNO_3

21. Give reason for the following:
    a. During the electrophilic substitution reaction of haloarenes, para substituted derivative is the major product.
    b. The product formed during S_N1 reaction is a racemic mixture.

OR

    a. Name the suitable alcohol and reagent, from which 2-Chloro-2-methyl propane can be prepared.
    b. Out of the Chloromethane and Fluoromethane , which one is has higher dipole moment and why?

22. The formula $Co(NH_3)_5CO_3Cl$ could represent a carbonate or a chloride. Write the structures and names of possible isomers.

23. Corrosion is an electrochemical phenomenon. The oxygen in moist air reacts as follows:

$$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq).$$

Write down the possible reactions for corrosion of zinc occurring at anode, cathode, and overall reaction to form a white layer of zinc hydroxide.

24. Explain how and why will the rate of reaction for a given reaction be affected when
    a. a catalyst is added
    b. the temperature at which the reaction was taking place is decreased

25. Write the reaction and IUPAC name of the product formed when 2-Methylpropanal (isobutyraldehyde) is treated with ethyl magnesium bromide followed by hydrolysis.

SECTION C

This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each.

26. Write the equations for the following reaction:
    a. Salicylic acid is treated with acetic anhydride in the presence of conc. H_2SO_4
    b. Tert butyl chloride is treated with sodium ethoxide.
    c. Phenol is treated with chloroform in the presence of NaOH

27. Using Valence bond theory, explain the following in relation to the paramagnetic complex $[Mn(CN)_6]^{3-}$
    a. type of hybridization
    b. magnetic moment value
    c. type of complex – inner, outer orbital complex

28. Answer the following questions:
    a. State Henry's law and explain why are the tanks used by scuba divers filled with air diluted with helium (11.7% helium, 56.2% nitrogen and 32.1% oxygen)?
    b. Assume that argon exerts a partial pressure of 6 bar. Calculate the solubility of argon gas in water. (Given Henry's law constant for argon dissolved in water, K_H = 40kbar)

29. Give reasons for **any 3** of the following observations:
    a. Aniline is acetylated before nitration reaction.
    b. pK_b of aniline is lower than the m-nitroaniline.
    c. Primary amine on treatment with benzenesulphonyl chloride forms a product which is soluble in NaOH however secondary amine gives product which is insoluble in NaOH.
    d. Aniline does not react with methyl chloride in the presence of anhydrous $AlCl_3$ catalyst.

30. a. Identify the major product formed when 2-cyclohexylchloroethane undergoes a dehydrohalogenation reaction. Name the reagent which is used to carry out the reaction.
    b. Why are haloalkanes more reactive towards nucleophilic substitution reactions than haloarenes and vinylic halides?

OR

    a. Name the possible alkenes which will yield 1-chloro-1-methylcyclohexane on their reaction with HCl. Write the reactions involved.
    b. Allyl chloride is hydrolysed more readily than n-propyl chloride. Why?

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

31. Strengthening the Foundation: Chargaff Formulates His "Rules"

Many people believe that James Watson and Francis Crick discovered DNA in the 1950s. In reality, this is not the case. Rather, DNA was first identified in the late 1860s by Swiss chemist Friedrich Miescher. Then, in the decades following Miescher's discovery, other scientists--notably, Phoebus Levene and Erwin Chargaff--carried out a series of research efforts that revealed additional details about the DNA molecule, including its primary chemical components and the ways in which they joined with one another. Without the scientific foundation provided by these pioneers, Watson and Crick may never have reached their groundbreaking conclusion of 1953: that the DNA molecule exists in the form of a three-dimensional double helix.

Chargaff, an Austrian biochemist, as his first step in this DNA research, set out to see whether there were any differences in DNA among different species. After developing a new paper chromatography method for separating and identifying small amounts of organic material, Chargaff reached two major conclusions:

(i) the nucleotide composition of DNA varies among species.

(ii) Almost all DNA, no matter what organism or tissue type it comes from maintains certain properties, even as its composition varies. In particular, the amount of adenine (A) is similar to the amount of thymine (T), and the amount of guanine (G) approximates the amount of cytosine (C). In other words, the total amount of purines (A + G) and the total amount of pyrimidines (C + T) are usually nearly equal. This conclusion is now known as "Chargaff's rule."

Chargaff’s rule is not obeyed in some viruses. These either have single- stranded DNA or RNA as their genetic material.

Answer the following questions:

a. A segment of DNA has 100 adenine and 150 cytosine bases. What is the total number of nucleotides present in this segment of DNA?
b. A sample of hair and blood was found at two sites. Scientists claim that the samples belong to same species. How did the scientists arrive at this conclusion?
c. The sample of a virus was tested and it was found to contain 20% adenine, 20% thymine, 20 % guanine and the rest cytosine. Is the genetic material of this virus (a) DNA- double helix (b) DNA-single helix (c) RNA? What do you infer from this data?

OR

How can Chargaff's rule be used to infer that the genetic material of an organism is double- helix or single- helix?

32. Henna is investigating the melting point of different salt solutions.
She makes a salt solution using 10 mL of water with a known mass of NaCl salt.
She puts the salt solution into a freezer and leaves it to freeze.
She takes the frozen salt solution out of the freezer and measures the temperature when the frozen salt solution melts.
She repeats each experiment.

S.No	Mass of the salt used in g	Melting point in ^{0}C	
		Readings Set 1	Reading Set 2
1	0.3	-1.9	-1.9
2	0.4	-2.5	-2.6
3	0.5	-3.0	-5.5
4	0.6	-3.8	-3.8
5	0.8	-5.1	-5.0
6	1.0	-6.4	-6.3

Assuming the melting point of pure water as 0^{o}C, answer the following questions:

a. One temperature in the second set of results does not fit the pattern. Which temperature is that? Justify your answer.
b. Why did Henna collect two sets of results?
c. In place of NaCl, if Henna had used glucose, what would have been the melting point of the solution with 0.6 g glucose in it?

OR

What is the predicted melting point if 1.2 g of salt is added to 10 mL of water? Justify your answer.

SECTION E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

33. a. Why does the cell voltage of a mercury cell remain constant during its

lifetime?

b. Write the reaction occurring at anode and cathode and the products of electrolysis of aq KCl.

c. What is the pH of HCl solution when the hydrogen gas electrode shows a potential of -0.59 V at standard temperature and pressure?

OR

a. Molar conductivity of substance "A" is 5.9×10^3 S/m and "B" is 1×10^{-16} S/m. Which of the two is most likely to be copper metal and why?

b. What is the quantity of electricity in Coulombs required to produce 4.8 g of Mg from molten $MgCl_2$? How much Ca will be produced if the same amount of electricity was passed through molten $CaCl_2$? (Atomic mass of Mg = 24 u, atomic mass of Ca = 40 u).

c. What is the standard free energy change for the following reaction at room temperature? Is the reaction spontaneous?

$Sn(s) + 2Cu^{2+}(aq) \rightarrow Sn^{2+}(aq) + 2Cu^{+}(s)$

34. A hydrocarbon (A) with molecular formula C_5H_{10} on ozonolysis gives two products (B) and (C). Both (B) and (C) give a yellow precipitate when heated with iodine in presence of NaOH while only (B) give a silver mirror on reaction with Tollen's reagent.

a. Identify (A), (B) and (C).

b. Write the reaction of B with Tollen's reagent

c. Write the equation for iodoform test for C

d. Write down the equation for aldol condensation reaction of B and C.

OR

An organic compound (A) with molecular formula $C_2Cl_3O_2H$ is obtained when (B) reacts with Red P and Cl_2. The organic compound (B) can be obtained on the reaction of methyl magnesium chloride with dry ice followed by acid hydrolysis.

a. Identify A and B

b. Write down the reaction for the formation of A from B. What is this reaction called?

c. Give any one method by which organic compound B can be prepared from its corresponding acid chloride.

d. Which will be the more acidic compound (A) or (B)? Why?

e. Write down the reaction to prepare methane from the compound (B).

35. Answer the following:

a. Why are all copper halides known except that copper iodide?

b. Why is the $E^o_{(V^{3+}/V^{2+})}$ value for vanadium comparatively low?

c. Why HCl should not be used for potassium permanganate titrations?

d. Explain the observation, at the end of each period, there is a slight increase in the atomic radius of d block elements.

e. What is the effect of pH on dichromate ion solution?

Sample Question Paper
Class XII
Session 2022-23
Mathematics (Code-041)

Time Allowed: 3 Hours **Maximum Marks: 80**

General Instructions :

1. This Question paper contains - **five sections** A, B, C, D and E. Each section is compulsory. However, there are internal choices in some questions.
2. **Section A** has 18 **MCQ's and 02** Assertion-Reason based questions of 1 mark each.
3. **Section B** has 5 **Very Short Answer (VSA)-type** questions of 2 marks each.
4. **Section C** has 6 **Short Answer (SA)-type** questions of 3 marks each.
5. **Section D** has 4 **Long Answer (LA)-type** questions of 5 marks each.
6. **Section E** has 3 **source based/case based/passage based/integrated units of assessment (**4 marks each**)** with sub parts.

SECTION A
(Multiple Choice Questions)
Each question carries 1 mark

Q1. If A =[a_{ij}] is a skew-symmetric matrix of order n, then
(a) $a_{ij} = \frac{1}{a_{ji}}\ \forall\ i,j$ (b) $a_{ij} \neq 0\ \forall\ i,j$ (c)$a_{ij} = 0, where\ i = j$ (d) $a_{ij} \neq 0\ where\ i = j$

Q2. If A is a square matrix of order 3, $|A'| = -3$, then $|AA'| =$
(a) 9 (b) -9 (c) 3 (d) -3

Q3. The area of a triangle with vertices A, B, C is given by
(a) $\left|\overrightarrow{AB} \times \overrightarrow{AC}\right|$ (b) $\frac{1}{2}\left|\overrightarrow{AB} \times \overrightarrow{AC}\right|$
(b) $\frac{1}{4}\left|\overrightarrow{AC} \times \overrightarrow{AB}\right|$ (d) $\frac{1}{8}\left|\overrightarrow{AC} \times \overrightarrow{AB}\right|$

Q4. The value of 'k' for which the function f(x) =$\begin{cases} \frac{1-cos4x}{8x^2}, if\ x \neq 0 \\ k, if\ x = 0 \end{cases}$ is continuous at x = 0 is
(a) 0 (b) -1 (c) 1. (d) 2

Q5. If $f'(x) = x + \frac{1}{x}$, then $f(x)$ is
(a) $x^2 + \log\ |x| + C$ (b) $\frac{x^2}{2} + \log\ |x| + C$ (c)$\frac{x}{2} + \log\ |x| + C$ (d) $\frac{x}{2} - \log\ |x| + C$

Q6. If m and n, respectively, are the order and the degree of the differential equation $\frac{d}{dx}\left[\left(\frac{dy}{dx}\right)\right]^4 = 0$, then m + n =
(a) 1 (b) 2 (c) 3 (d) 4

Q7. The solution set of the inequality 3x + 5y < 4 is
(a) an open half-plane not containing the origin.
(b) an open half-plane containing the origin.
(c) the whole *XY*-plane not containing the line 3x + 5y = 4.
(d) a closed half plane containing the origin.

Q8. The scalar projection of the vector $3\hat{\imath} - \hat{\jmath} - 2\hat{k}$ *on the vector* $\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$ is

(a) $\frac{7}{\sqrt{14}}$ (b)$\frac{7}{14}$ (c)$\frac{6}{13}$ (d) $\frac{7}{2}$

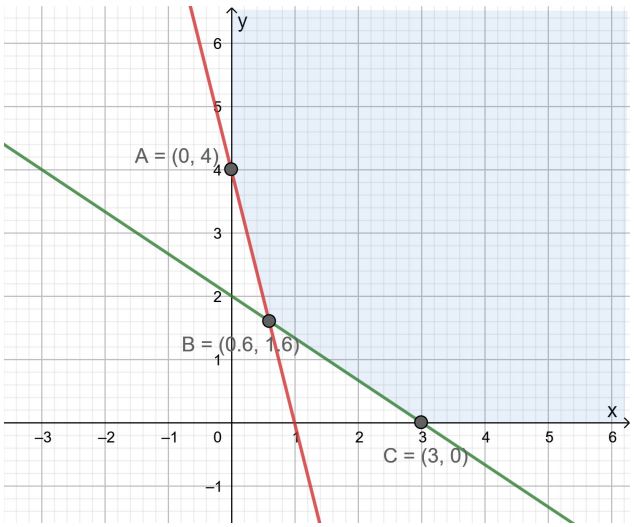
Q9. The value of $\int_2^3 \frac{x}{x^2+1}$dx is

(a) log4 (b) $log\frac{3}{2}$ (c) $\frac{1}{2}log2$ (d) $log\frac{9}{4}$

Q10. If A, B are non-singular square matrices of the same order, then $(AB^{-1})^{-1} =$

(a)$A^{-1}B$ (b)$A^{-1}B^{-1}$ (c)BA^{-1} (d) AB

Q11. The corner points of the shaded unbounded feasible region of an LPP are (0, 4), (0.6, 1.6) and (3, 0) as shown in the figure. The minimum value of the objective function Z = 4x + 6y occurs at



(a)$(0.6, 1.6)$ *only* (b) (3, 0) only (c) (0.6, 1.6) and (3, 0) only

(d) at every point of the line-segment joining the points (0.6, 1.6) and (3, 0)

Q12. If $\begin{vmatrix} 2 & 4 \\ 5 & 1 \end{vmatrix} = \begin{vmatrix} 2x & 4 \\ 6 & x \end{vmatrix}$, *then the possible* value(s) of 'x' is/are

(a) 3 (b) $\sqrt{3}$ (c) $-\sqrt{3}$ (d) $\sqrt{3}, -\sqrt{3}$

Q13. If A is a square matrix of order 3 and |A| = 5, then $|adjA| =$

(a) 5 (b) 25 (c) 125 (d) $\frac{1}{5}$

Q14. Given two independent events A and B such that P(A) =0.3, P(B) = 0.6 and P$(A' \cap B')$ is

(a) 0.9 (b) 0.18 (c) 0.28 (d) 0.1

Q15. The general solution of the differential equation $ydx - xdy = 0$ *is*

(a) $xy = C$ (b) $x = Cy^2$ (c) $y = Cx$ (d) $y = Cx^2$

Q16. If $y = sin^{-1}x$, then $(1 - x^2)y_2$ *is* equal to

(a) xy_1 (b) xy (c) xy_2 (d) x^2

Q17. If two vectors $\vec{a}\ and\ \vec{b}$ are such that $|\vec{a}| = 2$, $\left|\vec{b}\right| = 3\ and\ \vec{a}.\vec{b} = 4, then\ \left|\vec{a} - 2\vec{b}\right|$ is equal to

(a) $\sqrt{2}$ (b) $2\sqrt{6}$ (c) 24 (d) $2\sqrt{2}$

Q18. P is a point on the line joining the points $A(0,5,-2)$ and $B(3,-1,2)$. If the x-coordinate of P is 6, then its z-coordinate is

(a) 10 (b) 6 (c) -6 (d) -10

ASSERTION-REASON BASED QUESTIONS

In the following questions, a statement of assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q19. **Assertion (A)**: The domain of the function $sec^{-1}2x$ is $\left(-\infty, -\frac{1}{2}\right] \cup [\frac{1}{2}, \infty)$

Reason (R): $sec^{-1}(-2) = -\frac{\pi}{4}$

Q20. **Assertion (A)**: The acute angle between the line $\bar{r} = \hat{\imath} + \hat{\jmath} + 2\hat{k} + \lambda(\hat{\imath} - \hat{\jmath})$ and the x-axis is $\frac{\pi}{4}$

Reason(R): The acute angle θ between the lines

$\bar{r} = x_1\hat{\imath} + y_1\hat{\jmath} + z_1\hat{k} + \lambda\left(a_1\hat{\imath} + b_1\hat{\jmath} + c_1\hat{k}\right)$ and

$\bar{r} = x_2\hat{\imath} + y_2\hat{\jmath} + z_2\hat{k} + \mu\left(a_2\hat{\imath} + b_2\hat{\jmath} + c_2\hat{k}\right)$ is given by $cos\theta = \frac{|a_1a_2+b_1b_2+c_1c_2|}{\sqrt{a_1{}^2+b_1{}^2+c_1{}^2}\sqrt{a_2{}^2+b_2{}^2+c_2{}^2}}$

SECTION B

This section comprises of very short answer type-questions (VSA) of 2 marks each

Q21. Find the value of $sin^{-1}[sin\left(\frac{13\pi}{7}\right)]$

OR

Prove that the function f is surjective, where $f: N \to N$ such that

$$f(n) = \begin{cases} \frac{n+1}{2}, if\ n\ is\ odd \\ \frac{n}{2}, if\ n\ is\ even \end{cases}$$

Is the function injective? Justify your answer.

Q22. A man 1.6 m tall walks at the rate of 0.3 m/sec away from a street light that is 4 m above the ground. At what rate is the tip of his shadow moving? At what rate is his shadow lengthening?

Q23. If $\vec{a} = \hat{\imath} - \hat{\jmath} + 7\hat{k}\ and\ \vec{b} = 5\hat{\imath} - \hat{\jmath} + \lambda\hat{k}$, then find the value of λ so that the vectors $\vec{a} + \vec{b}\ and\ \vec{a} - \vec{b}$ are orthogonal.

OR

Find the direction ratio and direction cosines of a line parallel to the line whose equations are

$6x - 12 = 3y + 9 = 2z - 2$

Q24. If $y\sqrt{1-x^2} + x\sqrt{1-y^2} = 1$, *then prove that* $\frac{dy}{dx} = -\sqrt{\frac{1-y^2}{1-x^2}}$

Q25. Find $|\vec{x}|$ if $(\vec{x} - \vec{a}).(\vec{x} + \vec{a}) = 12$, where $\vec{a}$ is a unit vector.

SECTION C

(This section comprises of short answer type questions (SA) of 3 marks each)

Q26. Find: $\int \frac{dx}{\sqrt{3-2x-x^2}}$

Q27. Three friends go for coffee. They decide who will pay the bill, by each tossing a coin and then letting the "odd person" pay. There is no odd person if all three tosses produce the same result. If there is no odd person in the first round, they make a second round of tosses and they continue to do so until there is an odd person. What is the probability that exactly three rounds of tosses are made?

OR

Find the mean number of defective items in a sample of two items drawn one-by-one without replacement from an urn containing 6 items, which include 2 defective items. Assume that the items are identical in shape and size.

Q28. Evaluate: $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{tanx}}$

OR

Evaluate: $\int_0^4 |x - 1|\, dx$

Q29. Solve the differential equation: $ydx + (x - y^2)dy = 0$

OR

Solve the differential equation: $xdy - ydx = \sqrt{x^2 + y^2}\, dx$

Q30. Solve the following Linear Programming Problem graphically:

Maximize Z = 400x + 300y subject to $x + y \leq 200, x \leq 40, x \geq 20, y \geq 0$

Q31. Find $\int \frac{(x^3+x+1)}{(x^2-1)} dx$

SECTION D

(This section comprises of long answer-type questions (LA) of 5 marks each)

Q32. Make a rough sketch of the region $\{(x, y): 0 \leq y \leq x^2, 0 \leq y \leq x, 0 \leq x \leq 2\}$ and find the area of the region using integration.

Q33. Define the relation R in the set $N \times N$ as follows:
For (a, b), (c, d) $\in N \times N$, (a, b) R (c, d) iff ad = bc. Prove that R is an equivalence relation in $N \times N$.

OR

Given a non-empty set X, define the relation R in P(X) as follows:
For A, B $\in P(X), (A, B) \in R$ iff $A \subset B$. Prove that R is reflexive, transitive and not symmetric.

Q34. An insect is crawling along the line $\bar{r} = 6\hat{\imath} + 2\hat{\jmath} + 2\hat{k} + \lambda(\hat{\imath} - 2\hat{\jmath} + 2\hat{k})$ and another insect is crawling along the line $\bar{r} = -4\hat{\imath} - \hat{k} + \mu(3\hat{\imath} - 2\hat{\jmath} - 2\hat{k})$. At what points on the lines should they reach so that the distance between them is the shortest? Find the shortest possible distance between them.

OR

The equations of motion of a rocket are:
$x = 2t, y = -4t, z = 4t,$ where the time t is given in seconds, and the coordinates of a moving point in km. What is the path of the rocket? At what distances will the rocket be from the starting point O(0, 0, 0) and from the following line in 10 seconds?
$\vec{r} = 20\hat{\imath} - 10\hat{\jmath} + 40\hat{k} + \mu(10\hat{\imath} - 20\hat{\jmath} + 10\hat{k})$

Q35. If A = $\begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$, find A^{-1}. Use A^{-1} to solve the following system of equations
$2x - 3y + 5z = 11, 3x + 2y - 4z = -5, x + y - 2z = -3$

SECTION E

(This section comprises of 3 case-study/passage-based questions of 4 marks each with two sub-parts. First two case study questions have three sub-parts (i), (ii), (iii) of marks 1, 1, 2 respectively. The third case study question has two sub-parts of 2 marks each.)

Q36. **Case-Study 1**: Read the following passage and answer the questions given below.

The temperature of a person during an intestinal illness is given by
$f(x) = -0.1x^2 + mx + 98.6, 0 \le x \le 12$, m being a constant, where f(x) is the temperature in °F at x days.

(i) Is the function differentiable in the interval (0, 12)? Justify your answer.

(ii) If 6 is the critical point of the function, then find the value of the constant m.

(iii) Find the intervals in which the function is strictly increasing/strictly decreasing.

OR

(iii) Find the points of local maximum/local minimum, if any, in the interval (0, 12) as well as the points of absolute maximum/absolute minimum in the interval [0, 12]. Also, find the corresponding local maximum/local minimum and the absolute maximum/absolute minimum values of the function.

Q37. **Case-Study** 2: Read the following passage and answer the questions given below.

In an elliptical sport field the authority wants to design a rectangular soccer field with the maximum possible area. The sport field is given by the graph of $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

(i) If the length and the breadth of the rectangular field be 2x and 2y respectively, then find the area function in terms of x.

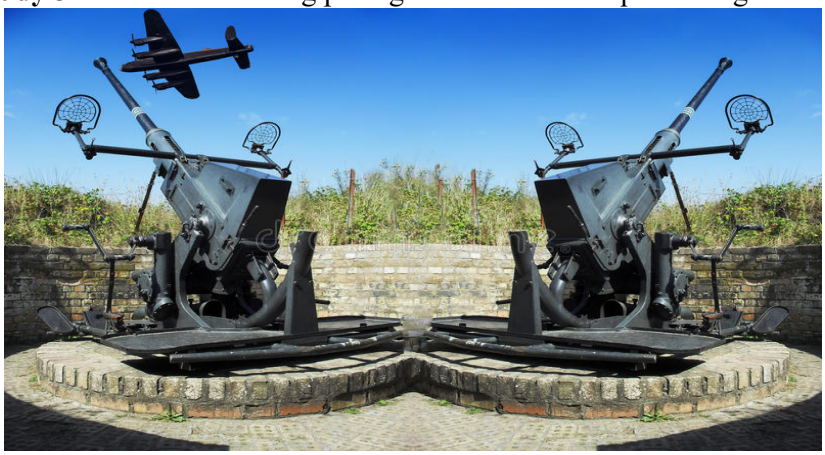
(ii) Find the critical point of the function.

(iii) Use First derivative Test to find the length 2x and width 2y of the soccer field (in terms of a and b) that maximize its area.

OR

(iii) Use Second Derivative Test to find the length 2x and width 2y of the soccer field (in terms of a and b) that maximize its area.

Q38. **Case-Study** 3: Read the following passage and answer the questions given below.



There are two antiaircraft guns, named as A and B. The probabilities that the shell fired from them hits an airplane are 0.3 and 0.2 respectively. Both of them fired one shell at an airplane at the same time.

(i) What is the probability that the shell fired from exactly one of them hit the plane?

(ii) If it is known that the shell fired from exactly one of them hit the plane, then what is the probability that it was fired from B?

Sample Question Paper

CLASS: XII

Session: 2022-23

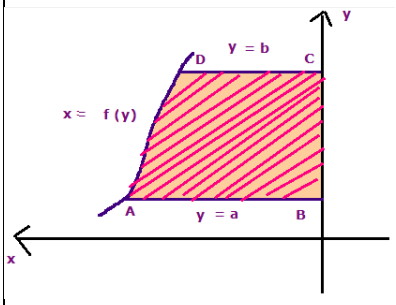
Applied Mathematics (Code-241)

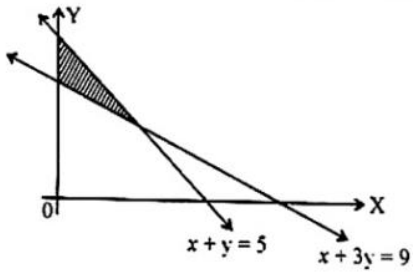
Time Allowed: 3 hrs **Maximum Marks: 80**

General Instructions:

1. This question paper contains five sections A, B, C, D and E. Each section is compulsory.
2. Section - A carries 20 marks weightage, Section - B carries 10 marks weightage, Section - C carries 18 marks weightage, Section - D carries 20 marks weightage and Section - E carries 3 case-based with total weightage of 12 marks.
   Section – A:
3. It comprises of **20 MCQs of 1 mark** each.
   Section – B:
4. It comprises of **5 VSA type questions of 2 marks** each.
   Section – C:
5. It comprises of **6 SA type of questions of 3 marks** each.
   Section – D:
6. It comprises of **4 LA type of questions of 5 marks** each.
   Section – E:
7. It has **3 case studies**. Each case study comprises of 3 case-based questions, where **2 VSA type questions are of 1 mark** each and **1 SA type question is of 2 marks**. Internal choice is provided in **2 marks** question in each case-study.
8. Internal choice is provided in **2 questions in Section - B**, **2 questions in Section – C, 2 questions in Section - D**. You have to attempt only one of the alternatives in all such questions.

	SECTION – A (All questions are compulsory. No internal choice is provided in this section)	**marks**
1.	What is the least value of 'x' that satisfies $x \equiv 27 (\text{mod } 4)$, when $27 < x \leq 36$? a) 27 b) 30 c) 31 d) 35	1
2.	Let $p > 0$ and $q < 0$ and $p, q \in Z$, then choose the correct inequality from the given below options to complete the statement: $\boldsymbol{p+q}$ ..... $\boldsymbol{p-q}$ a) $>$ b) $\leq$ c) $\geq$ d) $<$	1
3.	A machine makes car wheels and in a random sample of 26 wheels, the test statistic is found to be 3.07. As per the t-distribution test (of 5% level of significance), what can you say about the quality of wheels produced by the machine? (Use $t_{25}(0.05) = 2.06$) a) Superior quality b) Inferior quality c) Same quality d) Cannot say	1

4.	For the purpose of t-test of significance, a random sample of size (n) 34 is drawn from a normal population, then the degree of freedom (v) is - a) $\frac{1}{34}$ b) 33 c) 34 d) 35	1
5.	A person can row a boat along the stream of the river at 10 km/h and against the stream in 6 km/h. What is the speed of the stream flow? a) 1 km/h b) 2 km/h c) 4 km/h d) 5 km/h	1
6.	Standard deviation of a sample from a population is called a - a) Standard error b) Parameter c) Statistic d) Central limit	1
7.	Two water supplying trucks – A and B supply water to remote areas. Truck A is carrying 100 litres of water to a village 1.5 km away and truck B is delivering 80 litres of water to another village, 1 km away. Due to bad road conditions, each truck loses 20 ml water while travelling each metre distance. Which truck is able to deliver more water and by how much more? a) Truck A, 20 litres b) Truck B, 20 litres c) Truck A, 10 litres d) Truck B, 10 litres	1
8.	What is the face value of a sinking fund that yields a dividend of ₹1800 at 10% semi-annually? a) ₹ 3600 b) ₹18000 c) ₹ 24000 d) ₹ 36000	1
9.	In the given figure, the area bounded by the curve $x = f(y)$, y -axis and abscissa $y = a$ and $y = b$ is equal to - a) $\int_a^b f(y)dy$ b) $\int_a^b f(x)dx$ c) $\int_a^b \lvert f(y)\rvert\, dy$ d) $\int_a^b \lvert f(x)\rvert\, dx$ 	1
10.	A factory production is delayed for three weeks due to breakdown of a machine and unavailability of spare parts. Under which trend oscillation does this situation fall under? a) Seasonal b) Cyclical c) Secular d) Irregular	1
11.	A newspaper printing machine costs ₹ 4,80,000 and estimated scrap value of ₹ 25,000 at the end of its useful life of 10 years. What is its annual depreciation as per linear method? a) ₹ 4,550 b) ₹ 45,500 c) ₹ 50,500 d) ₹ 61,500	1

12.	In the given figure (I), what is the LPP shaded region known as?  **Figure (I)** a) Feasible region b) Feasible solution c) Optimal region d) Objective region	1
13.	General solution of differential equation: $ylogy\ dx - x\ dy = 0$ is – a) $y = \log\lvert Cx\rvert$ b) $y = e^{\lvert Cx\rvert}$ c) $y = e^{-Cx}$ d) $\log y = \lvert C + x\rvert$	1
14.	An investment of ₹ 10,000 becomes ₹ 60,000 in 4 years, then the CAGR (compound annual growth rate) is given by - a) $\frac{\sqrt[4]{6}-1}{100}$ b) $\frac{\sqrt[4]{6}+1}{100}$ c) $[\sqrt[4]{6}-1]\times 100$ d) $[\sqrt[4]{6}+1]\times 100$	1
15.	In what ratio shall I add water to the liquid detergent costing ₹ 480 per litre to get resulting mixture worth ₹ 300 per litre? a) 5:3 b) 3:8 c) 3:5 d) 5:8	1
16.	A grain whole-seller visits the granary market. While going around to make a good purchase, he takes a handful of rice from random sacks of rice, in order to inspect the quality of farmers produce. The handful of rice taken from a sack of rice for quality inspection is a: a) statistic b) population c) parameter d) sample	1
17.	For predicting the straight-line trend in the sales of scooters (in thousands) on the basis of 6 consecutive years data, the company makes use of 4-year moving averages method. If the sales of scooters for respective years are a, b, c, d, e and f respectively, then which of the following average will <u>not</u> be computed? a) $\frac{a+b+c+d}{4}$ b) $\frac{b+c+d+e}{4}$ c) $\frac{a+c+d+e}{4}$ d) $\frac{c+d+e+f}{4}$	1
18.	In a school, a random sample of 145 students is taken to check whether a student's average calory intake is 1500 or not. The collected data of average calories intake of sample students is presented in a frequency distribution, which is called a: a) Statistics b) Sampling distribution c) Parameter d) Population sampling	1

	For questions 19 and 20, two statements are given – one labelled Assertion(A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below: **(i) Both A and R are true and R is the correct explanation of the assertion** **(ii) Both A and R are true but R is not the correct explanation of the assertion** **(iii) A is true, but R is false** **(iv) A is false, but R is true** 1	
19.	Assertion (A) : Kuhu and Beena are two equally capable badminton players. Probability that Beena will beat Kuhu in 3 games out of 4 is 25% Reason (R) : The probability of r successes in n trials, denoted by P(X = r) is given by P(X = r) = ${}^{n}C_r\, p^r q^{n-r}$, $r = 0, 1, \ldots, n$ where p denotes success and q denotes failure in each trial. a) (i) b) (ii) c) (iii) d) (iv)	1
20.	Assertion (A) : If the nominal rate of interest is 12.5% and the inflation is 2%, then the effective rate of interest is 10.5% Reason (R) : If the interest is calculated only at the end of an year, then the effective rate of interest is same as the nominal rate of interest. a) (i) b) (ii) c) (iii) d) (iv)	1
	SECTION – B (All questions are compulsory. In case of internal choice, attempt any one question only)	
21.	₹ 2,50,000 cash is equivalent to a perpetuity of ₹ 7,500 payable at the end of each quarter. What is the rate of interest convertible quarterly?	2
22.	Find value of $2a + 3b - c$, if A = $\begin{bmatrix} 0 & -1 & 28 \\ a-8 & 0 & 3b \\ -c+2 & 2 & 0 \end{bmatrix}$ is a skew-symmetric matrix **OR** There are two real value(s) of x , for which the value of the determinant $\Delta = \begin{vmatrix} 1 & -2 & 5 \\ 2 & x & -1 \\ 0 & 4 & 2x \end{vmatrix}$ is 86. Find the value(s) of x	2
23.	A book publisher sells a hard cover edition of a book for ₹ 72 and a paperback edition for ₹ 40. In addition to a fixed weekly cost of ₹ 9,600, the cost of printing hardcover and paperback editions are ₹ 56 and ₹ 28 per book respectively. Each edition requires 5 minutes on the printing machine whereas hardcover binding takes 10 minutes and paperback takes 2 minutes on the binding machine. The printing machine and the binding machine are available for 80 hours each week. Formulate the linear programming problem to maximise the publisher's profit.	2
24.	A boatman takes half as much time in rowing his boat for a certain distance downstream than upstream. What is the ratio between his speed of rowing the boat in still water and speed of current?	2

	OR In a 200-metre race, Anuj can beat Param by 5 metre or 3 seconds. How much time did Anuj take to complete the race?	
25.	Mitul invested ₹ 3,50,000 in a fund. At the end of the year the value of the fund is ₹ 4,37,500. What is the nominal rate of interest, if the market price is same at the end of the year?	2
	SECTION – C (All questions are compulsory. In case of internal choice, attempt any one question only)	
26.	Find the interval(s) in which the function $f(x) = \frac{x^4}{4} - 2x^3 + \frac{11x^2}{2} - 6x$, is strictly increasing and strictly decreasing.	3
27.	Two badminton teams A and B are staying in the same hotel. Team A has 2 male and 3 female players accompanied by 1 coach. Team B comprises of 1 male, 2 female players and 2 coaches. The daily diet requirement (calories and protein) for each person is as given below: Use matrix algebra to calculate the total diet requirement of calories and protein for each team.	3
28.	Evaluate $\int \frac{dx}{(1+e^x)(1+e^{-x})}$ **OR** Evaluate $\int x\ log(1+x^2)\ dx$	3
29.	Under the pure market competition scenario, the demand function p_d and the supply function p_s for a certain commodity are given as $p_d = \frac{8}{x+1} - 2$ and $p_s = \frac{x+3}{2}$ respectively, where p is the price and x is the quantity of the commodity. Using integrals, find the producer's surplus. **OR** The demand function p for maximising a profit monopolist is given by $p = 274 - x^2$ while the marginal cost is $4 + 3x$, for x units of the commodity. Using integrals, find the consumer surplus	3
30.	Surjeet purchased a new house, costing ₹ 40,00,000 and made a certain amount of down payment so that he can pay the balance by taking a home loan from XYZ Bank. If his equated monthly instalment is ₹ 30,000, at 9% interest compounded monthly (reducing balance method) and payable for 25 years, then what is the initial down payment made by him? [Use $(1.0075)^{-300} = 0.1062$]	3
31.	10 years ago, Mr Mehra set up a sinking fund to save for his daughter's higher studies. At the end of 10 years, he has received an amount of ₹ 10,21,760. What amount did he put in the sinking fund at the end of every 6 months for the tenure, which paid him 5% p.a. compounded semi-annually? [Use $(1.025)^{20} = 1.6386$]	3

	Calories	Protein
Male player	2500	65 g
Female player	1900	50 g
Coach	2000	54 g

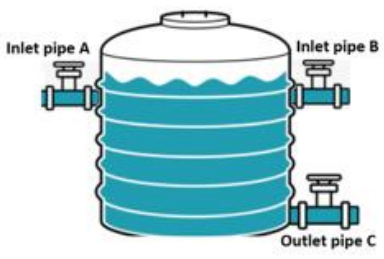
SECTION – D

(All questions are compulsory. In case of internal choice, attempt any one question only)

32.	It is known that 3% of plastic buckets manufactured in a factory are defective. Using the Poisson distribution on a sample of 100 buckets, find the probability of: (i) Zero defective buckets (ii) At most one bucket is defective [Use $e^{-3} = 0.049$] **OR** In a math aptitude test, student scores are found to be normally distributed having mean as 45 and standard deviation 5. What percentage of students have scores - (i) more than the mean score? (ii) between 30 and 50?	5
33.	An event management company charges ₹ 4,800 per guest, for a bulk booking for 100 guests. In addition, it offers a discount of ₹ 200 for each group of 10 guests over and above 100 guest booking. What is the number of guests that will maximise the amount of money the company receives on a booking? What is the maximum profit on such booking? **OR** To manufacture 'x' number of dolls, a company's total cost function C(x) is given by C $(x) = 100 + 0.025x^2$ and the total revenue function R (x) is described as R $(x) = 5x$. Given that C (x) and R (x) are in thousand rupees, what number of dolls shall be manufactured to maximise the profit of the company? What is the maximum profit?	5
34.	Rahul is at the whole sale market to purchase folding tables and chairs, to later sell them at his furniture shop. He has only ₹ 5,760 to spend and his van has space to carry at the most 20 items. A table costs him ₹ 360 and a chair costs ₹ 240. Back at his shop, he plans to sell a table at a profit of ₹ 22 and a chair at a profit of ₹ 18. Given that he can sell all the items that he purchases, how many tables and chairs shall he purchase in order to maximise his profit?	5
35.	The equilibrium conditions for three competitive markets are described as given below, where p_1, p_2 and p_3 are the equilibrium price for each market respectively. $$p_1 + 2p_2 + 3p_3 = 85$$ $$3p_1 + 2p_2 + 2p_3 = 105$$ $$2p_1 + 3p_2 + 2p_3 = 110$$ Using matrix method, find the values of respective equilibrium prices.	5

SECTION – E

(All questions are compulsory. In case of internal choice, attempt any one question only)

36.	**CASE STUDY – I** An overhead water tank has three pipes A, B and C attached to it (as shown in figure (II)). The inlet pipes A and B can fill the empty tank independently in 15 hours and 12 hours respectively. The outlet pipe C alone can empty a full tank in 20 hours. Based on the above information, answer the following questions. Show steps to support your answers.  FIGURE (II)	

a)	For a routine cleaning of the tank, the tank needs to be emptied. If pipes A and B are closed at the time when the tank is filled to two-fifth of its total capacity, how long will pipe C take to empty the tank completely?	1
b)	How long will it take for the empty tank to fill completely, if all the three pipes are opened simultaneously?	1
c)	On a given day, pipes A, B and C are opened (in order) at 5 am, 8 am and 9 am respectively, to fill the empty tank. In how many hours will the tank be filled completely? **OR** Given that the tank is half-full, only pipe C is opened at 6 AM, to empty the tank. After closing the pipe C and an hour's cleaning time, tank is filled completely by pipe A and B together. What is the total time taken in the whole process?	2

37. **CASE STUDY – II**

When observed over a long period of time, a time series data can predict trend that can forecast increase or decrease or stagnation of a variable under consideration. Such analytical studies can benefit a business for forecasting or prediction of future estimated sales or production.
Mathematically, for finding a line of best-fit to represent a trend, many methods are available. Methods like moving-averages and least-squares squares are some of the techniques to predict such trends.

Mrs. Shamita runs a bread factory and the record of her sales of bakery items for the period of 2015 - 2019 is as follows:

Year	2015	2016	2017	2018	2019
Sales (in ₹ thousands)	35	42	46	41	48

Based on the above information, answer the following questions. Show steps to support your answers.

a)	By taking year 2017 as origin, use method of least-squares to find the best-fit trend line equation for Mrs. Shamita's business. Show the steps of your working. **OR** Demonstrate the technique to fit the best-suited straight-line trend by the method of 3-years moving averages. Also draw the trend line.	2
b)	What are the estimated sales for Mrs. Shamita's business for year 2022?	1
c)	Mrs Shamita wishes to grow her business to yearly sale of ₹ 67400. In which year will she be able to reach her target?	1

38. **CASE STUDY – III**

According to an educational board survey, it was observed that class XII students apply at least one to four weeks ahead of colleges application deadline. Let X represent the week when an average student applies ahead of a college's application deadline and the probability of student to get admission in the college $P(X = x)$ is given as follows:

	$$P(X=x)=\begin{cases}\frac{kx}{6} & when\ x=0,1\ or\ 2\\ \frac{(1-k)x}{6} & when\ x=3\\ \frac{kx}{2} & when\ x=4\\ 0 & when\ x>4\end{cases}$$ Where k is a real number. Based on the above information, answer the following questions. Show steps to support your answers.	
a)	Find the value of k.	1
b)	What is the probability that Sonali will get admission in the college, given that she applied at least 2 weeks ahead of application deadline?	1
c)	Calculate the mathematical expectation of number of weeks taken by a student to apply ahead of a college's application deadline. **OR** To promote early admissions, the college is offering scholarships to the students for applying ahead of deadline as follows: ₹ 50000 for applying 4 weeks early, ₹ 20000 for applying 3 weeks early, ₹ 12000 for applying 2 weeks early, and ₹ 9600 for applying 1 week early What is the expected scholarship offered by the college?	2

Sample Question Paper 2022-23

CLASS XII

BIOLOGY (044)

Maximum Marks: 70 **Time: 3 hours**

General Instructions:

(i) All questions are compulsory.

(ii) The question paper has five sections and 33 questions. All questions are compulsory.

(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.

(iv) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.

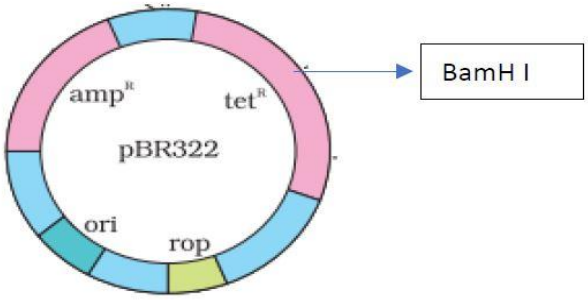
(v) Wherever necessary, neat and properly labeled diagrams should be drawn.

SECTION - A

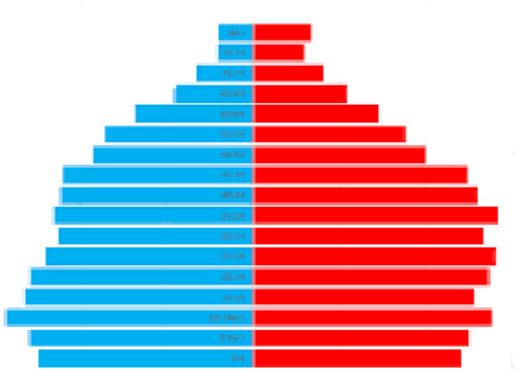
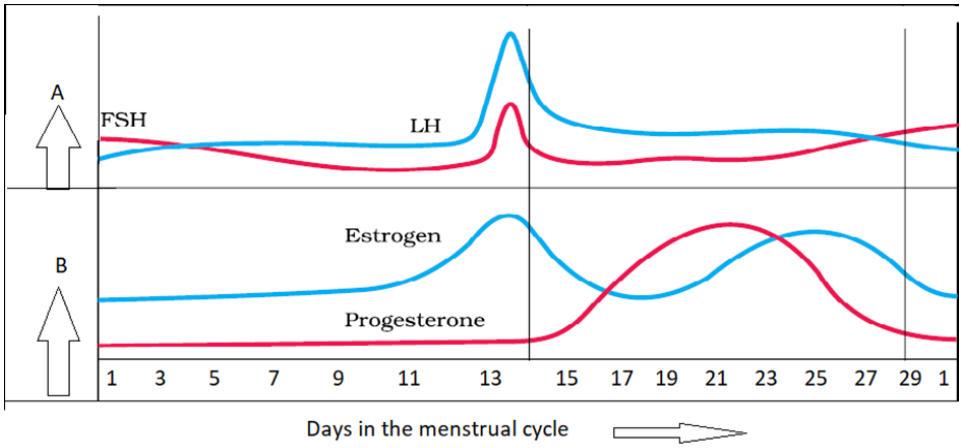
Q.No.	Question	Marks
1.	An infertile couple was advised to undergo In vitro fertilization by the doctor. Out of the options given below, select the correct stage for transfer to the fallopian tube for successful results? (a) Zygote only (b) Zygote or early embryo upto 8 blastomeres (c) Embryos with more than 8 blastomeres (d) Blastocyst Stage	1
2.	Given below are four contraceptive methods and their modes of action. Select the correct match: <table><tr><th>*S. No.*</th><th>*Method*</th><th>*S. No*</th><th>*Mode of action*</th></tr><tr><td>a)</td><td>Condom</td><td>(i)</td><td>Ovum not able to reach Fallopian tube</td></tr><tr><td>b)</td><td>Vasectomy</td><td>(ii)</td><td>Prevents ovulation</td></tr><tr><td>c)</td><td>Pill</td><td>(iii)</td><td>Prevents sperm reaching the cervix</td></tr><tr><td>d)</td><td>Tubectomy</td><td>(iv)</td><td>Semen contains no sperms</td></tr></table>(a) a)–(i) b)–(ii) c)– (iii) d)–(iv) (b) a)–(ii) b)–(iii) c)–(iii) d) – (i) (c) a)–(iii) b)–(iv) c)–(ii) d)–(i) (d) a)–(iv) b)–(i) c)– (iii) d)–(ii)	1

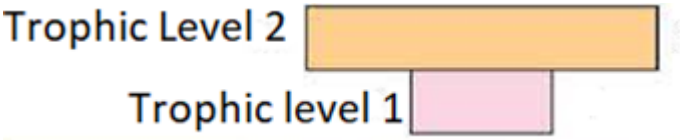
3	Which of the following amino acid residues will constitute the histone core? (a) Lysine and Arginine (b) Asparagine and Arginine (c) Glutamine and Lysine (d) Asparagine and Glutamine	1
4	Evolutionary convergence is development of a (a) common set of functions in groups of different ancestry. (b) dissimilar set of functions in closely related groups. (c) common set of structures in closely related groups. (d) dissimilar set of functions in unrelated groups.	1
5.	*Apis mellifera* are killer bees possessing toxic bee venom. Identify the treatment and the type of immunity developed from the given table to treat a person against the venom of this bee. *Remedy* — *Immunity* (a) Inactivated proteins — Active (b) Proteins of the venom — Passive (c) Preformed antibodies — Passive (d) Dead micro-organisms — Active	1
6.	Interferons are most effective in making non-infected cells resistant against the spread of which of the following diseases in humans? (a) ascariasis (b) ringworm (c) amoebiasis (d) AIDS	1
7.	Which of the following water samples in the table given below, will have a higher concentration of organic matter?	1

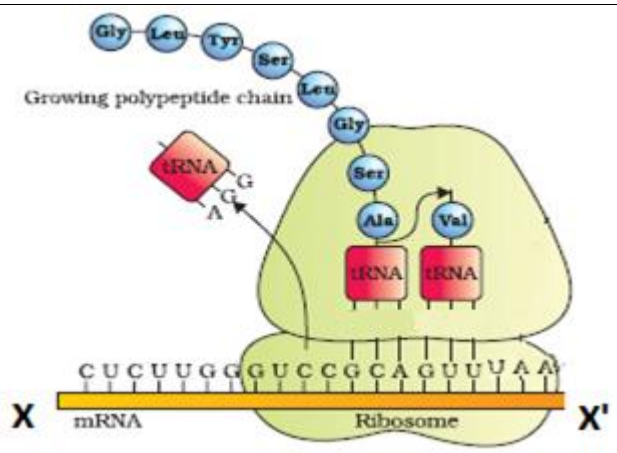
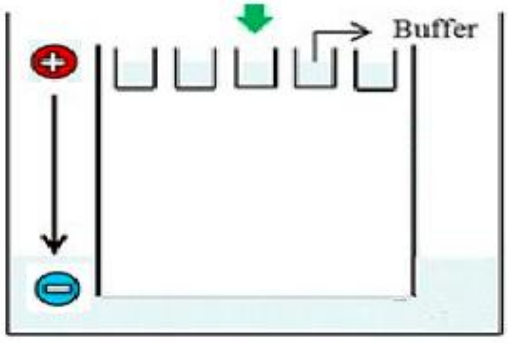
Water Sample	*Level of pollution*	*Value of BOD*
(a)	High	High
(b)	Low	Low
(c)	Low	High
(d)	High	Low

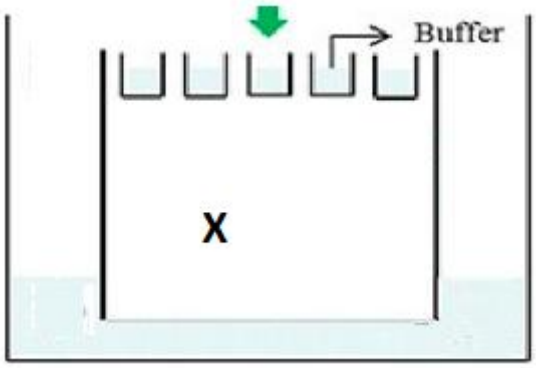
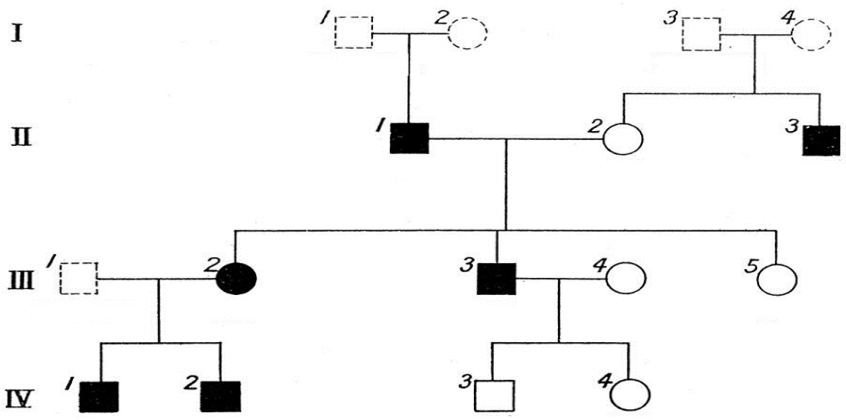
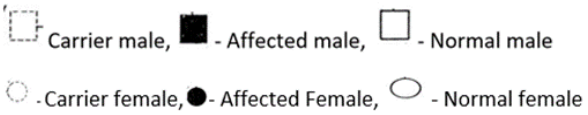
8.	The figure below shows the structure of a plasmid.  A foreign DNA was ligated at BamH1. The transformants were then grown in a medium containing antibiotics tetracycline and ampicillin. Choose the correct observation for the growth of bacterial colonies from the given table *Medium with Tetracycline* / *Medium with Ampicillin* (a) Growth / No growth (b) No growth / Growth (c) No growth / No Growth (d) Growth / Growth	1
9.	Swathi was growing a bacterial colony in a culture flask under ideal laboratory conditions where the resources are replenished. Which of the following equations will represent the growth in this case? *(Where population size is N, birth rate is b, death rate is d, unit time period is t, and carrying capacity is K).* (a) dN/dt = KN (b) dN/dt = r N (c) dN/dt = r N(K-N/K) (d) dN/dt = r N(K+N/K)	1
10.	Sea Anemone gets attached to the surface of the hermit crab. The kind of population interaction exhibited in this case is (a) amensalism. (b) commensalism. (c) mutualism. (d) parasitism.	1

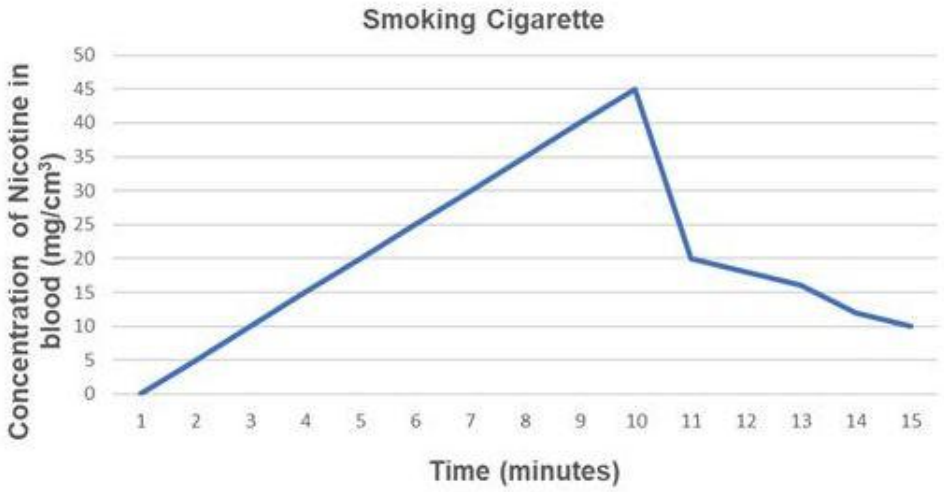
11.	Which of the following food chains is the major conduit for energy flow in terrestrial and aquatic ecosystems respectively? *Terrestrial Ecosystem* — *Aquatic Ecosystem* (a) Grazing — Grazing (b) Detritus — Detritus (c) Detritus — Grazing (d) Grazing — Detritus	1
12	Which of the following is an example of ex situ conservation? (a) Sacred Groves (b) National Park (c) Biosphere Reserve (d) Seed Bank	1
Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below: A. Both A and R are true and R is the correct explanation of A. B. Both A and R are true and R is not the correct explanation of A. C. A is true but R is false. D. A is False but R is true.		
13.	Assertion: Apomictic embryos are genetically identical to the parent plant. Reason: Apomixis is the production of seeds without fertilization.	1
14.	Assertion: When white eyed, yellow bodied *Drosophila* females were hybridized with red eyed, brown-bodied males; and F1 progeny was intercrossed, F2 ratio deviated from 9 : 3 : 3 : 1. Reason: When two genes in a dihybrid are on the same chromosome, the proportion of parental gene combinations is much higher than the non-parental type.	1
15.	Assertion: Functional ADA cDNA genes must be inserted in the lymphocytes at the early embryonic stage. Reason: Cells in the embryonic stage are mortal, differentiated and easy to manipulate.	1
16.	Given below is the Age Pyramid of population in one of the states in India as per 2011 census. It depicts the male population on the left hand side, female population on the right hand side, newborns towards the base and gradually increasing age groups as we move from base to the top, with the oldest population at the top. Study	1

	this pyramid and comment upon the appropriateness of the Assertionand theReason.  Assertion: It is a stable population. Reason: The pre-reproductive and reproductive individuals are almost in equal numbers and the post-reproductive individuals are relatively fewer.	
	SECTION - B	
17.	In the figure given below, parts A and B show the level of hormones which influence the menstrual cycle. Study the figure and answer the questions that follow:  (a) Name the organs which secrete the hormones represented in parts A and B. (b) State the impact of the hormones in part B on the uterus of the human female during 6 to 15 days of menstrual cycle?	2
18.	A true breeding pea plant, homozygous dominant for inflated green podsis crossed with another pea plant with constricted yellow pods (ffgg). With the help of punnett square show the above cross and mention the results obtained phenotypically and genotypically in F1 generation?	2
19	During a field trip, one of your friend in the group suddenly became unwell, she started sneezing and had trouble in breathing. Name and explain the term associated with such sudden responses. What would the doctor recommend for relief?	2

20	CTTAAG GAATTC (a) What are such sequences called? Name the enzyme used that recognizes such nucleotide sequences. (b) What is their significance in biotechnology?	2
21	(a) Given below is a pyramid of biomass in an ecosystem where each bar represents the standing crop available in the trophic level. With the help of an example explain the conditions where this kind of pyramid is possible in nature?  (b) Will the pyramid of energy be also of the same shape in this situation? Give reason for your response. **OR** (a) Draw a pyramid of numbers where a large number of insects are feeding on the leaves of a tree. What is the shape of this pyramid? (b) Will the pyramid of energy be also of the same shape in this situation? Give reason for your response.	2
	SECTION - C	
22	Explain the functions of the following structures in the human male reproductive system. (a) Scrotum (b) Leydig cells (c) Male accessory glands	3
23	State the agent(s) which helps in pollinating in the following plants. Explain the adaptations in these plants to ensure pollination: (a) Corn (b) Water hyacinth (c) Vallisneria	3
24	(a) Identify the polarity of x to x' in the diagram below and mention how many more amino acids are expected to be added to this polypeptide chain.	3

	 (b) Mention the codon and anticodon for alanine. (c) Why are some untranslated sequences of bases seen in mRNA coding for a polypeptide? Where exactly are they present on mRNA?	
25	(a) How is Hardy-Weinberg's expression "$(p^2 + 2pq+q^2) = 1$"derived? (b) List any two factors that can disturb the genetic equilibrium.	3
26	Highlight the structural importance of an antibody molecule with a diagram. Name the four types of antibodies found to give a humoral immune response, mentioning the functions of two of them you have studied. **OR** (a) Explain the Life cycle of *Plasmodium* starting from its entry in the body of female *Anopheles* till the completion of its life cycle in humans. (b) Explain the cause of periodic recurrence of chill and high fever during malarial attack in humans.	3
27	Carefully observe the given picture. A mixture of DNA with fragments ranging from 200 base pairs to 2500 base pairs was electrophoresed on agarose gel with the following arrangement.  (a) What result will be obtained on staining with ethidium bromide? Explain with reason. (b) The above set-up was modified and a band with 250 base pairs was obtained at X.	3

	 What change(s) were made to the previous design to obtain a band at X? Why did the band appear at the position X?	
28	(a) There was loss of biodiversity in an ecosystem due to a new construction project in that area. What would be its impact on the ecosystem? State any three. (b) List any three major causes of loss of biodiversity?	3
	SECTION - D	
Q.no 29 and 30 are case based questions. Each question has subparts with internal choice in one subpart.		
29	Study the Pedigree chart given below and answer the questions that follow:  Symbols used in the given Pedigree Chart are as follows:  (a) On the basis of the inheritance pattern exhibited in this pedigree chart, what conclusion can you draw about the pattern of inheritance? (b) If the female is homozygous for the affected trait in this pedigree chart, then what percentage of her sons will be affected ?	4

	(c) Give the genotype of offsprings 1,2,3 and 4 in III generation. **OR** (c) In this type of inheritance pattern, out of male and female children which one has less probability of receiving the trait from the parents. Give a reason.	
30.	The data below shows the concentration of nicotine smoked by a smoker taking 10 puffs/ minute.  (a) With reference to the above graph explain the concentration of nicotine in blood at 10 minutes. (b) How will this affect the concentration of carbon monoxide and haembound oxygen at 10 minutes? (c) How does cigarette smoking result in high blood pressure and increase in heart rate? **OR** (c) How does cigarette smoking result in lung cancer and emphysema?	4
	SECTION - E	
31	Trace the events from copulation to zygote formation in a human female. **OR** Trace the development of a megaspore mother cell to the formation of mature embryo sac in a flowering plant.	5
32.	Observe the segment of mRNA given below.	5

(a) Explain and illustrate the steps involved to make fully processed hnRNA?

(b) Gene encoding RNA Polymerase I and III have been affected by mutation in a cell. Explain its impact on the synthesis of polypeptide, stating reasons.

OR

Study the schematic representation of the genes involved in the lac operon given below and answer the questions that follow:

(a) The active site of enzyme permease present in the cell membrane of a bacterium has been blocked by an inhibitor, how will it affect the lac operon?

(b) The protein produced by the i gene has become abnormal due to unknown reasons. Explain its impact on lactose metabolism stating the reason.

(c) If the nutrient medium for the bacteria contains only galactose; will operon be expressed? Justify your answer.

33. Oil spill is a major environmental issue. It has been found that different strains of *Pseudomonas* bacteria have genes to break down the four major groups of hydrocarbons in oil. Trials are underway to use different biotechnological tools to incorporate these genes and create a genetically engineered strain of *Pseudomonas* - a *'super-bug'*, to break down the four major groups of hydrocarbons in oil. Such bacteria might be sprayed onto surfaces polluted with oil to clean thin films of oil. 5

(a) List two advantages of using bacteria for such biotechnological studies?

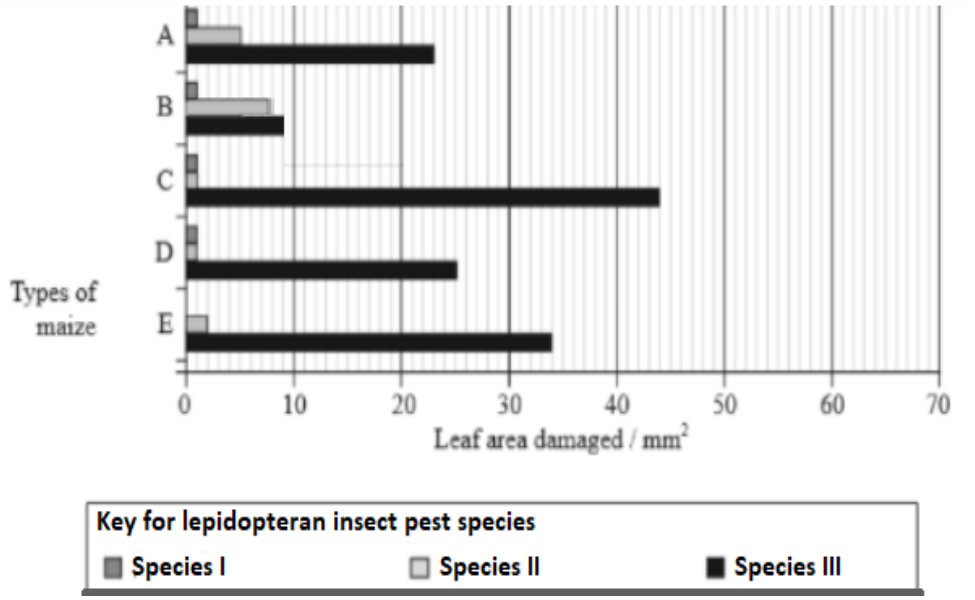
(b) For amplification of the gene of interest PCR was carried out. The PCR was run with the help of polymerase which was functional only at a very low temperature. How will this impact the efficiency of the PCR? Justify.

(c) If such bacteria are sprayed on water bodies with oil spills, how will this have a positive or negative effect on the environment? Discuss.

OR

Insects in the Lepidopteran group lay eggs on maize crops. The larvae on hatching feed on maize leaf and tender cob. In order to arrest the spread of three such Lepidopteran pests, Bt maize crops were introduced in an experimental field.
A study was carried out to see which of the three species of lepidopteran pests was

most susceptible to Bt genes and its product.
The lepidopteran pests were allowed to feed on the same Bt-maize crops grown on 5 fields (A-E).
The graph below shows the leaf area damaged by these three pests after feeding on maize leaves for five days.



Insect gut pH was recorded as 10, 8 and 6 respectively for Species I, II and III respectively.

(a) Evaluate the efficacy of the Bt crop on the feeding habits of the three species of stem borer and suggest which species is least susceptible to Bt toxin.
(b) Which species is most susceptible to Bt-maize, explain why?
(c) Using the given information, suggest why similar effect was not seen in the three insect species?